International Journal of Database Theory and Application
Vol.9, No.6 (2016), pp.265-274
http://dx.doi.org/10.14257/ijdta.2016.9.6.27

Research on Database Remote Disaster Recovery and Backup Technology Based on Multi Point and Multi Hop

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Abstract

Object: With the continuous advancement of information technology, more and more systems use database to store basic data, the security of data is an important part of the design of the business system. Method: In order to effectively improve the viability of data, this paper proposes a kind of multi point and multi hop database remote disaster recovery and backup technology. Process: Based on the in-depth analysis of the functions and demand of database, this paper introduces the working principles and key technologies of disaster recovery technology, describes the principles and realization process of multi point and multi hop database remote disaster recovery and backup technology, and carries on the experimental analysis. Conclusion: Theoretical analysis and experimental results show that this method is an effective new way of database remote disaster recovery and backup. So this technology has many advantages, such as multi point and multi hop backup, good real-time performance, fine backup granularity and so on.

Keywords: *Disaster backup; disaster recovery database; remote replication; asynchronous replication*

1. Introduction

With the continuous advancement of the social information process, the information systems of enterprises and institutions are more and more dependent on the database; most of the key data are stored in the database. The loss or damage of the database data will cause the immeasurable loss of the enterprises and institutions. Database disaster becomes a high-profile research hot spot in the field of information security. Based on the in-depth analysis of the functions and demand of database, this paper introduces the working principles and key technologies of disaster recovery technology, describes the principles and realization process of multi point and multi hop database remote disaster recovery and backup technology. The method monitors the local database in real time, packages the data changes into records, and writes in the massive buffer. Then the records in massive buffer are asynchronously and simultaneously sent to multiple remote level 1 databases, and the data changes are replayed in these remote level 1 databases, the data changes of remote level 1 database are monitored and copied to multiple remote level 2 database, so as to realize the multi point and multi hop disaster recovery and backup of local database data. This technology has the following advantages: The technology supports for multi-point and multi hop backup, and the backup point can relay; database data have multiple backups in different regions, which greatly improves the survival ability of the database data; good real-time of which can achieve zero data loss; the backup granularity is fine, and the backup efficiency is high; the requirements of backup line are low, which can be directly on the slow and stable line; in addition, its implementation is simple and flexible. Finally, the experimental analysis is carried out;

ISSN: 2005-4270 IJDTA

the experimental results show that this technology is an effective a new way of database remote disaster recovery and backup.

2. Description of the Problem

At present, the research of disaster recovery and remote replication technology is mainly concentrated in the foreign countries, the disaster recovery products or technologies that they provide generally need to set up a dedicated line or optical fiber channel, the cost of which is expensive, and the backup granularity is coarse, which often carries on the backup to the entire disk partition. While the Oracle, SQL Server, Sybase and other database systems providing the remote disaster recovery functions on the basis of the database log replication technology, but these technologies have following defects: When initialization, we must use the full backup of the local database to establish the remote database, the data transmission is large, and the network bandwidth is high; The replication efficiency is low, and the database log not only stores the database data, but also a lot of additional information; The real-time performance is poor, only when the data changes of the local database reach a certain threshold, which can be transmitted to the remote to carry on replaying; Flexibility is poor, the users can't just back up some of the key data tables according to their needs. In recent years, there have developed the disaster recovery technology based on disk array and storage area network SAN in the domestic. But most of these techniques can only achieve local data disaster tolerance, the backup line requirement of which is high, and the cost is expensive, the distance is limited. Based on this, this paper proposes the multi point and multi hop database remote disaster recovery and backup method. This method backs up the local database data to a number of remote databases in the form of the multi point and multi hop, which supports for the relaying of the backup point, so that the local database data has multiple backup, which greatly improves the survival ability of database data; The fine backup granularity effectively improves the backup efficiency, the massive data caching mechanism effectively solves the contradiction between the local data bandwidth and the bandwidth of the backup line, reduces the requirements for the backup line, so that the distance is not limited.

3. Database Remote Disaster Recovery and Backup Technology

3.1. Disaster Recovery and Backup Technology

The disaster recovery system refers to establish two or more sets IT systems with the same function in the distant places, which can carry out health status monitoring and switching function each other. When a system stops working with an accident (such as fire, earthquake), the whole application system can be switched to another place, so that the function of the system can continue the normal operation. Disaster recovery technology is a part of the high availability technology of the system, the disaster recovery system more emphasizes on the effect of external environment on the system, especially the impact of catastrophic events on the whole IT node, so as to provide the node level system recovery function. From the protection degree of the system, the disaster recovery and backup technology can be divided into: data disaster recovery and application disaster recovery.

3.2. Data Disaster Recovery

The data disaster recovery refers to establish a remote data system, the system is an available copy of the local key application data. When the local data and the entire application system appear disaster, the system stores at least one available key business

data in different places. The data can be completely reproduced in real time with the local production data, it also can be slightly backward than the local data, but it must be available. The main technologies are data backup and data replication technology. Data disaster recovery technology is also known as remote data replication technology, in accordance with the implementation of technical terms, which can be divided into synchronous transmission mode and asynchronous transmission mode. In addition, there is "semi synchronous". Semi synchronous transfer mode is the same as the synchronous transmission mode. According to the distance of data disaster recovery, this also can be divided into remote data disaster recovery and short range data disaster recovery mode.

3.3. Index of Disaster Recovery Technology

From a technical point of view, the measurement of disaster recovery system has three main indicators: RPO (Recovery Point Objective), RTO (Recovery Time Objective) and the backup window. RPO, namely the data recovery point objective, which mainly refers to the amount of data lost that can be tolerated by the business system. In the mode of synchronous data replication, RPO is equal to the time of data transmission delay. In the mode of asynchronous data replication, RPO is basically equal to the time of the asynchronous data transmission. RTO, namely the maximum time that can tolerate the business to stop serving, that is, the shortest time cycle that required from the disaster occurred to the business system to restore the service functions. RTO describes the time that spent on the recovery process.

RPO is for the data lost, and RTO is for the service lost, so there is no necessary connection between the two. The determination of RTO and RPO must be determined after carrying out the risk analysis and business impact analysis and according to different business needs. For the same business of different enterprises, the needs of RPO and RTO are different. The smaller the RPO and RTO, the higher the system availability. At present, the international general standard of review of disaster recovery system is Share78:

The scope of backup / restore;
The state of the disaster recovery plan;
The distance between business center and disaster recovery center;
How the two centers connect with each other;
How the data is transferred between the two centers;
How much the data is allowed to loose;
How to ensure the updated data is updated in the disaster recovery center;
The ability of disaster recovery center can begin the process of disaster.

Share78 is just a review of standard that built in the disaster recovery system, it is necessary to provide more specific design index in the design of disaster recovery system. The final purpose of the establishment of disaster tolerant system is to be able to recover the data service at the fastest speed after the disaster, so the main design index of disaster recovery center is related to the data recovery ability of the disaster recovery system.

3.4. Key Technology of Disaster Recovery System

The technologies of data disaster recovery backup system commonly used including mirroring image technology, snapshot technology, continuous data protection technology and data deduplication technology and so on.

Mirroring Technology

Mirroring is a form of data redundancy, which is the process of making the data on a disk or multiple disk systems to generate the copy of the data in exactly the same. It is divided into the main mirroring system and the mirroring system. According to the different location, which is divided into local mirroring and remote mirroring. The master slave system of the local mirroring is in a local area network, and the master slave mirroring system of the remote mirroring is connected with the wide area network.

Snapshot Technology

The definition of SNIA (Storage Network Industry Association) on snapshot is: For a fully usable copy of a particular data set, the data set contains a static image of the source data in a copy point; it is a copy of the data reproduction. Snapshot is actually the establishment of a data table, which saves the data pointer of the source data on the storage device, the role of which is to provide online backup and recovery services, users can access the snapshot data without the effect of the normal operation of the application system meta data, the data can be recovered to the time points when the disaster occurs.

Continuous Data Protection Technology

CDP, it is a kind of continuous data protection, which can continue to capture or track any change of the target data without affecting the main data operation, and can effectively protect the data when the data occur any change. The biggest advantage of which is that the data can be recovered at any time point. CDP can provide block level, file level and application level backup and recovery.

Data Deduplication Technology

Data deduplication technology is also known as the single instance storage (refers to SIR) or capacity optimization, as the name suggests, its fundamental role is to reduce the duplication of data storage, so that any data saves only a case, so as to achieve the purpose of making full use of storage space. From the principle of the work, data deduplication technology can be divided into two kinds, one is the data deduplication based on the Hash algorithm, and one is the data deduplication based on the contents of the identification.

4. Implementation of Multi Point and Multi Hop Database Remote Disaster Recovery and Backup

4.1. Basic Ideas

The core of the multi point and multi hop database remote disaster recovery and backup method includes 3 parts: Local monitoring, network communication and remote replay. The local monitoring system is mainly responsible for monitoring data changes in the source database, intercepting the data and operations of the source database changes, and then encapsulating the data into the data change record.

Network communication is divided into sending sub module and receiving sub module, which establishes the data transmission channel through the TCP protocol, and transfers the data change record. The remote playback part receives data from the network communication module, which is resolved to the collection of the replay command, the collection of the replay command is executed, and the data changes are reproduced on the target database. In order to facilitate the discussion, some terms are defined here:

Definition 1 (source database) the database needs to be backed up

Definition 2 (target database) Sub target of source database

Definition 3 (source server) Source database server

Definition 4 (target server) Target database server

Definition 5 (multi point) the source database can be directly used to backup multiple target databases

Definition 6 (multi hop) The local database data can be back up to the remote level 2 database, but there is no direct backup between the two databases, and the backup point can be relay.

Definition 7 (data change record collection R) recording the data changes operation of the source database, a record is corresponding to an operation, the operation including insert, delete, update.

Definition 8 (mass buffer Q) A cyclic queue of data changes on the source server.

$$Q = (r_1, r_2 \ldots r_n) \quad r_i \in R \quad i=1,2,\ldots,n. \tag{1}$$

4.2. Architecture of System

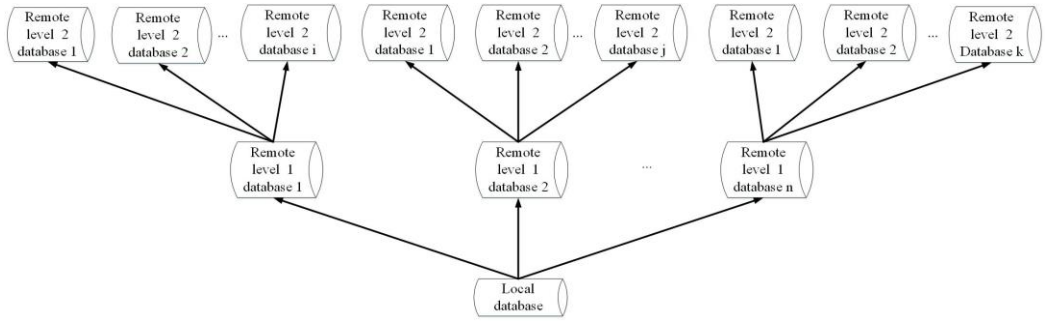

Figure 1. Architecture of Multi Point and Multi Hop Database Remote Disaster Recovery and Backup

The data changes of local database data are copied to multiple remote level 1 database in real-time, then the remote level 1 database completes the relay, and copies the data changes to the multiple remote level 2 database in real-time, so that the multi point and multi hop database remote disaster recovery and backup is realized.

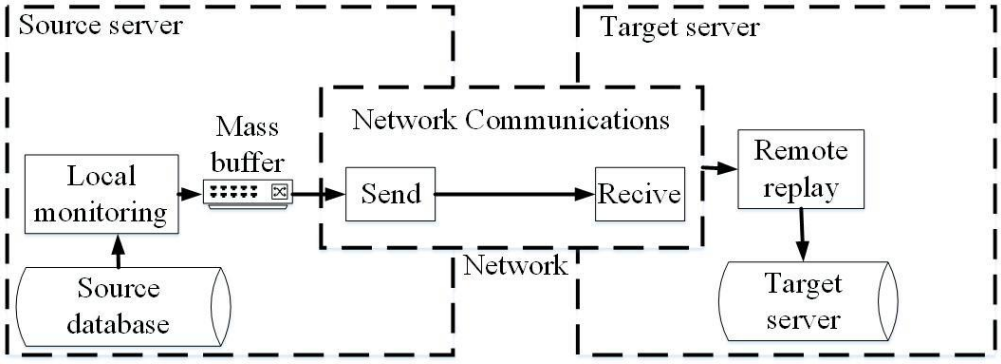

Figure 2. Backup Principle

Data monitoring is carried out through the field level of the source database, and the operation of the data changes of the source database is intercepted. In accordance with the order of each operation change occurs, each data change operation of the database is acquired in real-time, and wrote in the local mass buffer with a certain format, then asynchronously sends the record in the mass buffer to the target server through the network. On the target server, the data change records are resolved, and the corresponding data changes are reduced, and the sequence of them is submitted to the target database according to the database. The working principles of each module are described in detail below.

4.3. Local Monitoring

In order to improve the efficiency of the backup and obtain the size of the fine backup, the data monitoring is conducted in the field. The local monitoring module is registered in the database system as the middle ware, and once the source database changes, which can get a good real-time performance. In order to solve the contradiction between the local data backup bandwidth and line bandwidth, reduce the bandwidth requirements of backup line and occupation of other network resources, and improve the efficiency of the system. So this method can also be tolerated even if there is a failure of the backup route, or the bandwidth is not stable.

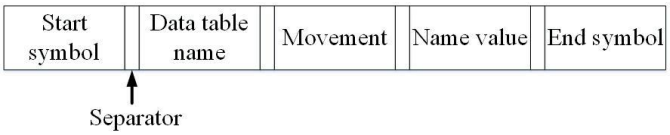

Figure 3. Data Change Record Format

Among them, the range of action domains: {insert, delete, and update}.

4.4. Network Communication

Because of the instability of non-line or Internet, and in order to ensure the correctness of data transmission, the error control method is introduced into the remote data transmission. The error control method has the advantage of testing whether the data is intact in the transmission process from the source server to the target server, so as to ensure the correctness of data transmission.

In order to easy to describe the work principle of the error control method, the following definitions are used:

H: Abstract computational functions, such as MD5, SHA-1, and so on.

R: The current data changes of source server side.

E: The corresponding summary values for the current data changes of the source server.

U: Network transmission data unit

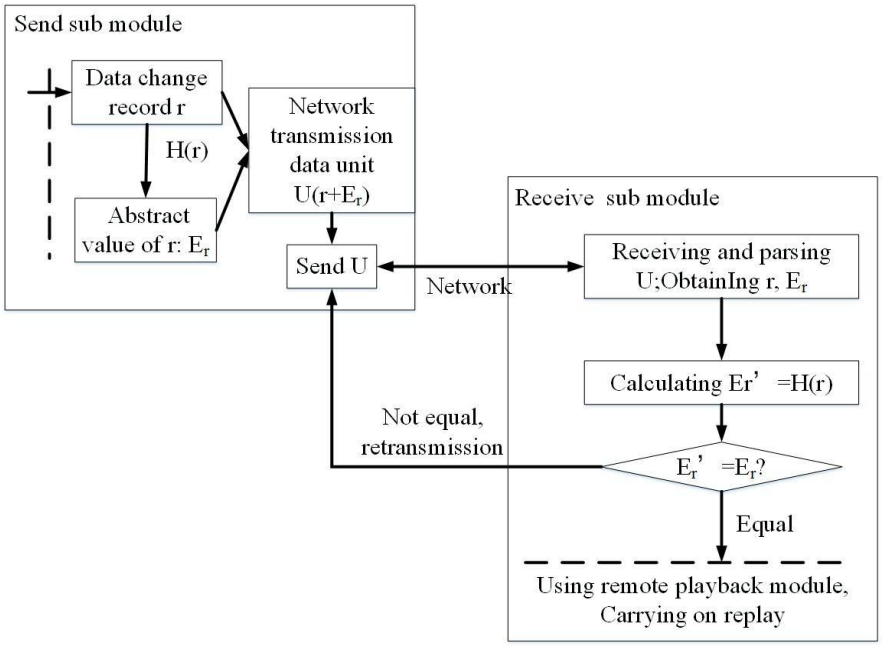

Figure 4. Working Principle Diagram of Error Control Method

The sending sub module of network communication module is responsible for removing the data change record r from the mass buffer, calculating its summary value E_r, packaging r, E_r into the network transmission data unit U, and then sending to the target server. The receiving sub module of the target server is responsible for receiving the network transmission data unit U, parsing the r, E_r, and re calculating the relevant summary values E_r'. If $E_r'=E_r$, it indicates that the current data transmission is complete, otherwise, it indicates that the change of data records r in the transmission process is destroyed, thus it is needed to carry on re transmission. And only in the condition of ensuring data transmission integrity, the remote playback module is called, and the replay is carries out.

4.5. Remote Playback

The data change record records the data change operation of the source database. The remote playback module is responsible for analyzing the data change record, and reducing it to the data change operation. And submitting to the target database, so as to achieve the source database data changes on the target database replay.

5. Experimental and Analysis

For the local database P, remote level 1 database A_1, A_2, remote level 2 database B_1, B_2, B_3, B_4, the data of P is copied to A_1 and A_2, the data of A_1 is copied to B_1 and B_2, the data of A_2 is copied to B_3 and B_4. Because the backup point of A_1, A_2 have the relay capability, the data of P can be copied to B_1, B_2, B_3, B_4 through the A_1, A_2, thus the data backup of P on A_1, A_2, B_1, B_2, B_3, B_4 is completed, that is, the multi point and multi hop database remote disaster recovery and backup of P is completed.

In the experiment, the database server configurations are the same: P41.80GHz processor, 512MB memory, IDE 40GB hard drive, PRO/100 VE Intel network card, Windows 2000 operating system, 9i Oracle database system. The bandwidth controller software is used to control the bandwidth of the network, and the simulation experiment is carried out under the condition of 3Mbps.

Compared the time that spent on copying the amount of data change of the local database P to A_1 with the time that spent on copying the amount of data change to B_1 in the form of multi point and multi hop. As shown in Figure 5, the backup time of P to B_1 is two times for P to A_1, because the backup path length of the former is two times than the latter, so which is consistent with the previous analysis results.

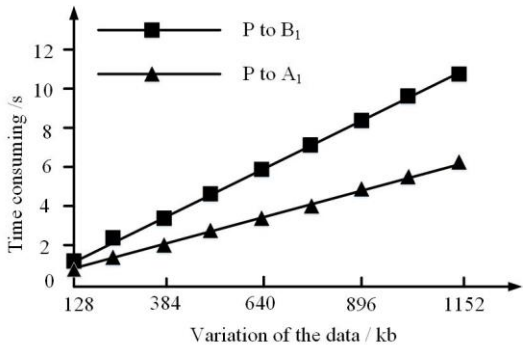

Figure 5. Backup Time

In order to simulate the real situation of the database application, the inserting, modifying, deleting and other operations are carried out on the local database P, so as to access to the data generated traffic flow and backup traffic changes curve of P, as shown in Figure 6.

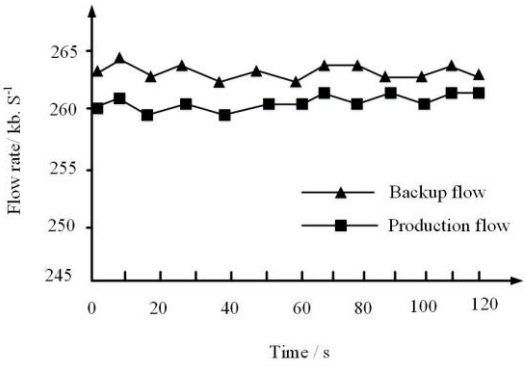

Figure 6. P Data Generated Traffic Flow and Back Up Traffic Change Curve of P

Backup flow is slightly greater than the generated traffic, which shows that the amount of data changes of P is copied to A_1, A_2 in time, if the P occurs disaster, P data will not be lost.

The experimental results show that in the slow non steady line, it is a good method to carry on the multi point and multi hop database remote disaster recovery and backup, and achieve zero data loss.

6. Conclusion

With the continuous advancement of the social information process, database disaster becomes a high-profile research hot spots in the field of information security. Based on the in-depth analysis of the functions and demand of database, this paper introduces the working principles and key technologies of disaster recovery technology, describes the principles and realization process of multi point and multi hop database remote disaster recovery and backup technology. The method monitors the local database in real time, packages the data changes into records, and writes in the massive buffer. Then the records

in massive buffer are asynchronously and simultaneously sent to multiple remote level 1 databases, and the data changes are replayed in these remote level 1 databases, the data changes of remote level 1 database are monitored and copied to multiple remote level 2 database, so as to realize the multi point and multi hop disaster recovery and backup of local database data. Finally, the experimental analysis is carried out, the experimental results show that this technology is an effective a new way of database remote disaster recovery and backup.

Acknowledgments

This article is supported by 2015 scientific research project of the Guangxi Zhuang Autonomous Region colleges and Universities: Research and application of data backup gateway, and the number of it is KY2015YB495.

Reference

[1] T. Zhiyuan, Y. Jian and G. Yunping, "GoldenGate technology based on the realization of the service platform of remote backup solution", Mobile communication, vol. 35, no. 14, **(2011)**, pp. 67-71.
[2] L. Guangping, "Computer disk array and remote backup system", Communication of science and technology, vol. 7, **(2012)**, pp. 146
[3] X. Bin and C. Kai, "The realization of data disaster recovery technology and application", Network security, no. 2, **(2014)**, pp. 89-90.
[4] Z. Zhihui, "And implementation of CD-ROM software and application", Computer data backup method, no. 8, **(2012)**, pp. 36-36.
[5] M. X. Kun, Y. J. Wu and W. Peng, "Based on the construction of cloud computing data center disaster recovery system", China Medical equipment, vol. 29, no. 1, **(2014)**, pp. 93-95.
[6] F. Jianhua and Z. Wen, "Disaster recovery backup architecture in the resistance factors", Shaanxi Science Institute of Technology: Natural Science Edition, vol. 27, no. 1, **(2011)**, pp. 54-59.
[7] X. P. Liu, "How to use virtualization technology important application system data remote backup", Office automation: the realization of a comprehensive monthly, no. 1, **(2013)**, pp. 43-45.
[8] H. M. Wang, M. Daosheng and Z. Yong, "Disaster recovery technology, product and application of analysis and research", Computer knowledge and technology: academic exchanges, no. 5, **(2014)**, pp. 2914-2918
[9] L. Yue and S. Bing, "Study on information system disaster recovery technology", China media technology, no. 12, **(2013)**, pp. 74-77.
[10] H. Jue and Z. Bowen, "CDP technology application level remote disaster recovery scheme", Computer knowledge and technology: academic exchanges based on, no. 7, **(2015)**, pp. 15-16.
[11] W. Mengmeng, W. Yuliang and Z. Tiefeng, "Application of SQLServer database of application level data protection system", computer system applications, vol. 24, no. 2, **(2015)**, pp. 93-98.
[12] Z. Shunshi, D. Guangwang and Z. Xu, "Based on business database disaster recovery system", Computer knowledge and technology, **(2012)**, pp. 29: 010.
[13] C. Shenghua and W. Deyan, "Remote data backup and recovery of the application of", information technology, no. 13, **(2012)**, pp. 45-45.
[14] C. Kang, "Local backup and disaster recovery system of off-site construction of",. information communication, no. 5, **(2012)**, pp. 151-152.
[15] H. Le, "Data disaster recovery technology research on", electronic technology, vol. 24, no. 3, **(2011)**, pp. 20-21.

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